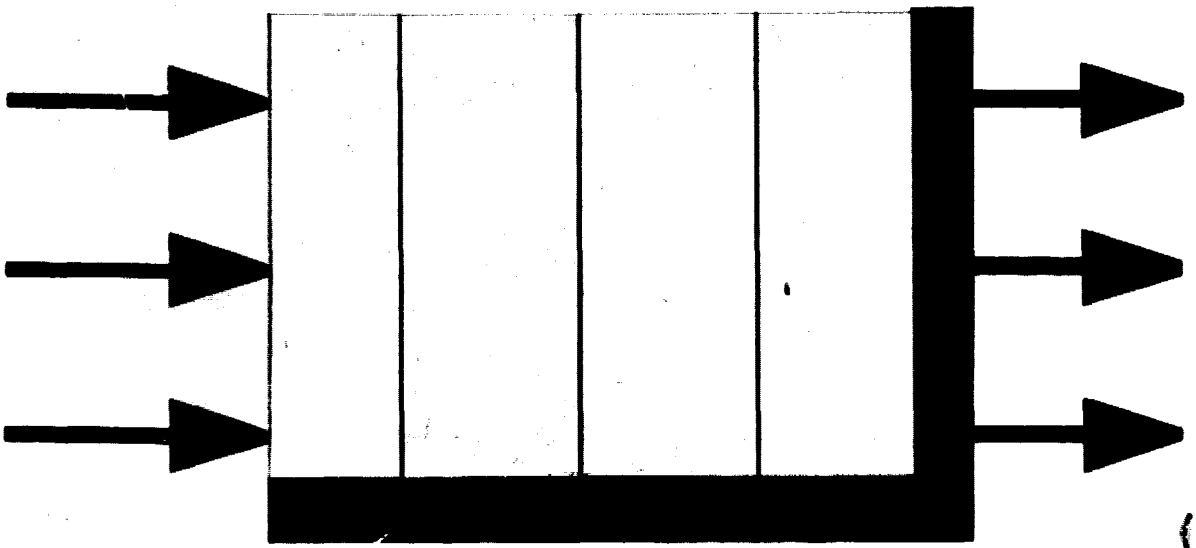

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IMPLEMENTATION AND TESTING OF A NEIGHBORHOOD OFFICE CENTER (NOC) AND INTEGRATION OF THE NOC WITH AN ADMINISTRATIVE CORRESPONDENCE MANAGEMENT INFORMATION SYSTEM

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1.0 INTRODUCTION

A special inter-Center task team established in 1974 at the request of the Deputy Administrator was charged with investigating ways in which telecommunications and telecomputing could reduce the Agency's consumption of scarce natural resources and the proliferation of paper copies of correspondence. A primary result of this effort was the recommendation to establish four specific pilot projects to investigate the feasibility of this approach*. Two of the projects represented new efforts:

- An interactive data management system for standardized budget reporting throughout NASA.

- A management information system for handling Headquarters administrative correspondence.

The other two were to upgrade and enhance systems already in existence:

- The NASA Teleconference Network.

- Space-shuttle data base management, including configuration control, problem reporting, and corrective action for reliability and quality assurance.

During the study, the task team came to realize that any of the four proposed projects, if implemented, could create a capability for exchanging voice messages, video images, and digital data within a totally self-sustaining communications network. This in turn suggested the possibility of eventually using such a capability for evaluating a new concept of work, based on decentralized (remote) neighborhood offices linked

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* cf. Final Report, NASA Headquarters Task Team on the Applications of Computers and Communications, Code E, June 1974

together through such a network, which could certainly be constructed within the current state-of-the-art. The concept came to be known as the Neighborhood Office Center (NOC). At the suggestion of the Deputy Administrator, the NOC concept formed the subject of a fifth effort to determine its feasibility, quantify its operational advantages, and identify its limitations.

A study of the NOC concept, undertaken in 1975, reported* that the current technological state-of-the-art was adequate to support the scheme, and that the benefits to be gained by such applications of digital data processing and communications could include reduced consumption of fuel in vehicles used for travel, a decrease in all expenses normally incurred by both employer and employee as a result of commuting or long distance travel, a reduction in the amount of paper consumed by conventional correspondence procedures, and various convenience factors associated with elimination of many travel requirements and decreased commuting time.

At the same time, a survey of current management information systems (MIS) used for correspondence tracking showed that the implementation of the second pilot project cited above was straightforward and well within realization, requiring only a commitment to begin development and a decision as to the specifics of the hardware configuration to be adopted.

Also related to these actions, a decision was reached within the Office of Applications to establish an Administrative Office Center (AOC) service based on the use of (non-communicating) magnetic-medium word-processing typewriters to handle the bulk of the daily typing load generated within Code E.

It was felt that the establishment of the three systems, viz. NOC, MIS and AOC, operating in close connection with an

* "A Study of the Remote Neighborhood Office Center Concept", S. Ross and Company, Final Report Contract NASw-2743, 31 August 1976

augmented teleconference network, might ultimately form a unified means of creating, storing and retrieving administrative documents, records and data, while simultaneously permitting users of the system to track their status. Much of this would probably involve the transfer of information and access to the contents of documents without using paper at all, that is, merely through digital electronic communications and display—an important step towards the establishment of a true Agency-wide electronic mail system.

The above considerations motivated the study effort whose findings are summarized in the present report. The goals of the effort were to undertake, on a preliminary basis, (a) the implementation, demonstration and testing of the NOC concept, and (b) the evaluation of the three other pilot projects cited above, i.e. MIS, AOC, and teleconference network—all in the present context. This first year was devoted to testing NOC, MIS, AOC and teleconference functions separately. By treating these functions on an individual basis, problems that might arise within each area could be addressed directly without the further complication of crosscoupling effects among them. Having identified and addressed the principal individual factors involved in equipment performance, communications and operator interface, we feel confident now to move forward to the next step, which is to begin combining these functions into a multifunctional system with which to test a unified administrative support program.

The results of the studies described in this report formed the basis for a system concept we have adopted for implementing the next phase of testing. The recommended configuration, a plan for conducting the tests under the next phase, and an accounting of the costs associated with undertaking the tests will be presented in a test plan to be issued at the start of the forthcoming effort.

Section 2 of this report describes our experiences with the Neighborhood Office Center in two of the configurations in which it was tested. The first configuration employed a stay-at-home typist, while the second involved a full-time NOC operator in a Georgetown business office. Section 3 explains the development and use of the Management Information System. In Section 4 an explanation of the teleconference evaluation procedure is presented. Finally, Section 5 discusses the development and processing of forms used to evaluate the performance of the Code EC Administrative Office Center.

2.0 NEIGHBORHOOD OFFICE CENTER (NOC)

2.1 Conceptual Approach

The long-term approach centers around the establishment of a scattered group of suburban administrative support offices which in themselves constitute a kind of simulation of an ultimate network of fully implemented neighborhood office centers. Most of the fundamental procedural problems that would likely be experienced in the full configuration of office centers are perforce to be found in the small-scale administrative support office environment as well, viz. the difficulties involved in communicating nuances of thought between people who are separated by large distances, dealing with equipment reliability problems, determining the minimal levels of ability and skills required to operate the equipment in a satisfactory manner, the need for scheduling jobs among several centers, and the complementary problem of coordinating inputs from several locations—even simply keeping track of the current status of any job—will require careful coordination of system hardware and support software with effective administrative techniques.

This first-year effort concentrated on establishing a link between a single work station and a single user location. The aim was to establish procedures necessary for smooth communication of raw and finished products, to investigate the level of performance of off-the-shelf equipment in the present application, and to uncover unanticipated problems in working at a distance.

Three major functions were undertaken:

- o reception of in-coming material;
- o processing (typing and editing) material; and

- transmission of completed material back to the originator (or to some other destination, if requested).

The discussion below describes the implementation of these functions, the current and planned configurations of the experimental NOC, and the experience gained to date in its operation.

2.2 Initial NOC Configuration

The first simulation of the environment of a Neighborhood Office Center, as recommended by the task team, resulted in the establishment of an office-like configuration maintained by a stay-at-home typist. We felt that such an approach would not only constitute a legitimate simulation of an NOC, but would also provide valuable information on the possibilities of working at home in general. Typical candidates for the stay-at-home typist included mothers who would look forward to the opportunity to work without the inconvenience and expense of child care, and perhaps those living with elderly or incapacitated relatives who could not leave their homes.

A simple three-line newspaper advertisement for a home-base typist brought almost 100 responses, most of them from women who were not in business as typists--surely an indication of what must be a large potential work force for such applications. Interviews of candidates resulted in the choice of a young Chevy Chase housewife with an infant child. Formerly employed downtown as a typist, she could no longer leave the house for extended periods of time while her child was so young. As a home-based typist, however, she could attend to domestic duties while still performing the tasks necessary to keep the NOC responsive to its clients. The desirability of this arrangement was further enhanced by the elimination of travel requirements

for her.

The various functions to be implemented required several different items of communication hardware to be installed at the NOC in Chevy Chase. This installation was not accomplished, however, without the solution of several logistics problems involving liability for the equipment itself and for any injuries that might be caused by the equipment. These problems arise when either Government-owned or commercially-owned equipment is installed in a private home; they require careful investigation of insurance regulations.

Incoming material is in either hard copy or dictated form. Handwritten or typed hard copy was transmitted initially over regular telephone lines between two Magnafax telecopier terminals. Transmission time for the Magnafax equipment was four or six minutes per page depending on the resolution required; six minutes was usually necessary to insure acceptable copies of typewritten input. The NOC Magnafax was equipped with a continuous roll of paper and a feeder mechanism that allowed the stay-at-home typist to be free to perform other tasks once the transmission from the other telecopier had begun. Both terminals had to be attended initially to allow synchronization of the transmission; automatic answering could not be performed by the Magnafax equipment. The transmitting terminal had to be serviced each time a new page was transmitted, unless the material to be transmitted was contained on a single continuous roll of paper.

The time and effort required to transmit hard copy via Magnafax between the NOC and NASA Headquarters made it clear that a more efficient telecopier was necessary. Furthermore, the quality of Magnafax copies was barely adequate in the case of material with fine detail. These factors, coupled with NASA's widespread use of Rapifax 100 telecopiers as part of its Teleconference

Network, led to a decision to install a Rapifax 100 in the NOC. The Rapifax was able to feed and receive (unattended) automatically, at an average rate of one page every 90 seconds, thus increasing significantly the efficiency of the stay-at-home typist's operation. The Rapifax also provided a fast means of transmitting edited hard copy, particularly in draft form, back to the originator.

Incoming dictation was recorded at the experimental NOC on magnetic discs with a six-minute capacity using an IBM 6:5 Tone Input System. Linked to a standard telephone line with an RDMZR coupler (which was installed properly only when those familiar with previously installed equipment corrected the wiring errors of telephone company personnel), this system answers a user's call automatically and emits "talk-down" tones that indicate whether the recorder is stopped or ready for further dictation. By touching buttons 1 through 6 on a Touchtone telephone, the user can stop the recorder, continue, rewind a disc to any point, eject a disc and continue with the next, issue special instructions, call the NOC attendant, and end the dictation session. The ability to re-record discs by transmission from the AOC to the NOC over a standard telephone line with the aid of a Message Unit was demonstrated. This capability will be used more extensively during the next phase of the project.

The dictated material received at the NOC tends to contain primarily the body of the document without regard for format or for the number and destination of carbon copies required. We have made every effort—with considerable success—to accept material in this form and to coordinate details with secretaries within Code EC. At times we have left the appropriate spaces at the beginning and end of various documents so that the secretaries could fill them in before returning the documents to their originators for editing. The secretaries also corrected acronyms and technical terms with which they were familiar.

The heart of the experimental NOC was a Wang 1222 TC telecommunicating dual-cassette typewriter, a word processor that allows the typist to delete, insert, replace, re-order, re-format, and in other ways manipulate text that she enters through an IBM Selectric keyboard and stores on magnetic tape cassettes. By changing the Selectric typing element, she can create the same letter in different type faces or insert Greek symbols and words in Italics. The Wang 1222 TC is equipped with a vertical half-space platen and both 10- and 12-pitch spacing. Once she edited her input material, the typist was ready to transmit a finished product back to the originator.

The telecommunicating feature of the Wang 1222 TC allows it to transmit directly to another 1222 TC or to a computer. Until the installation of another 1222 TC was completed at NASA Headquarters, as described later, the procedure involved transmission via telephone line to an IBM 360 computer at the National Institutes of Health in Bethesda, Maryland. A word processing software package known as WYLBUR was used by the 360 to extract and store (on magnetic discs) the information received from the Wang 1222 TC. When the stay-at-home typist was ready to transmit the completed material to WYLBUR, she accessed the computer in Bethesda from her Wang 1222 TC through an Anderson-Jacobson A242 acoustic coupler interfaced into an unconditioned voice-grade phone line, unloading the appropriate file from her magnetic tape cassette.

To retrieve stored text, any remote computer terminal could be used to access WYLBUR. Ordinarily, retrieval was performed at NASA Headquarters using an IBM 2741 terminal—a Selectric typewriter with a communicating feature. The same log-in procedure was used downtown to retrieve information from WYLBUR as had been used to store it moments before (or days before) at the NOC. To safeguard the information stored in a central

computer, the downtown operator had to know the file name under which the stay-at-home typist stored the text. Once the file name had been told to the retriever, the text could be typed out at the 2741 as entered at the NOC, or the operator could choose to edit the text further using WYLBUR. While the use of an intermediate computer involved a slight additional expense over direct 1222-to-1222 transmission and a need to interact with and attend the receiving terminal, it provided the advantage of having access to the text from virtually any regular telephone line if a computer terminal, portable or otherwise, were available. This feature would allow an executive or a secretary with a portable terminal at home to edit information that could be retrieved in final typed form at the office the next day. This increase in productivity is an important advantage to be considered in an operational NOC configuration.

To allow unattended transmission of hard copy to NASA Headquarters from the NOC, and to maximize the use of the various word processing functions available on the Wang 1222 TC, a Wang unit identical to that at the NOC was installed at NASA Headquarters several months later. This unit was equipped with a Bell 103A3 Dataset that provided an automatic answer option. With the auto answer option the stay-at-home typist could manipulate the two tape cassettes in the word processor at Headquarters without the assistance or intervention of another operator, and regardless of the time of day. When she finished copying her work onto the tapes at Headquarters, the finished product could be run off by another operator the next morning.

The Chevy Chase NOC was used by NASA Headquarters for a variety of typing and other administrative support tasks. On December 9, 1975 the NOC facilities and personnel were used to demonstrate successfully the concept of remote stenography. The stay-at-home typist was patched into a Headquarters Office of Applications Status Review via the NASA Teleconference Network,

and recorded the minutes of the public affairs presentation. The minutes were typed at the NOC, transmitted to the computer at NIH, and retrieved and reviewed at Headquarters using an IBM 2741 terminal. The minutes of that portion of the meeting were distributed before the meeting adjourned.

The flexibility afforded by the use of the intermediate computer made possible the establishment of communications with the NASA Goddard Space Flight Center as well. Several Magnafax transmissions to the NOC followed by keyboarding, editing, and transmission to WYLBUR took place during January 1976. Final copy was retrieved through GE Terminet terminals at GSFC.

The establishment of the stay-at-home experiment as a simulation of an operating NOC proved the feasibility of the overall concept. Furthermore, the experience gained in the course of simulating the NOC provided considerable insight into the relative advantages and disadvantages of the stay-at-home configuration in particular. Some of the aspects that were found to degrade the practical effectiveness of the stay-at-home configuration are as follows:

- Although it was originally intended that the typist should use friends and neighbors to staff the NOC when she was not available, it soon became clear that the logistics of making and distributing keys to her home and of coordinating schedules of availability were difficult to implement. Even more difficult to accommodate was the potential inconvenience that would result from several people using her home at various times of the day. Finally, the part-time nature of the tasks that would be performed by the neighbors made the ratio of training to actual performance abnormally high; stated more simply, proficiency in operating the NOC equipment—in particular the Wang telecommunicating

word processor—requires extended periods of concentration and practice that would reduce the already limited time available for production work. The use of CRT-based word processors is expected to simplify this process and thus to reduce training time.

- o If the home-based typist's circumstances change and she decides to stop working or wants to change her hours of availability, it becomes disruptive and expensive to maintain the service or to transfer it to a different location. As our typist's child grew more active he also demanded more attention. It became possible—even desirable—to take him for strolls or to the playgound. This shifted her availability for NOC work to the evening hours. Maintenance of equipment and repairs became difficult to arrange, because the equipment suppliers could not guarantee when they would be at her house, and she didn't want to be constrained to wait for them to come. Also, it became difficult for job initiators to communicate with her (and vice versa) because she was often unavailable during the day. Editorial remarks, unclear handwriting, incomprehensible dictation and complex tables all require ready access and a chance to interact with the job initiator. Then too, if a decision is made to relocate the equipment, the cost of moving and re-establishing it is quite high relative to the volume of work that is normally processed through the office; when the NOC was later transferred downtown to a more conventional office environment, the costs amounted to over $500, and several weeks were required to bring in new lines and set up the equipment again.

- o An NOC station with a single operator is less efficient in terms of telephone line utilization than an

operational NOC with a dedicated line shared by enough users to keep it fully occupied all day long. But any one typist spends most of the time entering and editing text off-line, and has no use for the line until the finished text is to be transmitted. This argues strongly in favor of multi-operator NOCs with data concentrators used to transmit buffered (finished) text in a steady stream between typists and initiators.

2.3 Full-time Office-based NOC

Once the initial stay-at-home typing experiment had been completed, plans for the next phase involving full-time NOC operation within a normal office environment were begun in accordance with the task team program plan. Accordingly, in mid-September 1976 the equipment was moved to the Georgetown office of S. Ross and Company for use on a steady basis by a full-time operator. An operator with prior word processing experience was hired, and was able to learn to use all the equipment within a few days.

All the equipment used by the stay-at-home typist was reinstalled in the Georgetown NOC, except for the Rapifax communication line. Initially, the Rapifax was connected to a standard commercial line with a CBT 1001B DAA line interface. When a transmission to or from the NOC was required, an operator at the Headquarters Rapifax had to dial the Gateway Switchboard at Marshall Space Flight Center (MSFC) using a five-digit number on the NASA Rapifax network line. Gateway would in turn dial the commercial number of the NOC Rapifax on an FTS line and patch the Headquarters Rapifax from the Gateway Switchboard to the off-net number in Georgetown. Thus, to communicate between two machines three miles apart, transmission to Huntsville, Alabama and back through two switchboards connecting three distinct networks was required.

This initial mode of Rapifax operation resulted in successful data transmission on only a limited number of occasions. The numerous failures that occurred were traced to a serious loss of signal (at least 5dB) through the Gateway Switchboard and again through the transition to a number off the FTS network. Furthermore, this mode of operation required an attendant at the Headquarters machine to dial MSFC and request that the NOC Rapifax be dialed in turn when material was ready to be transmitted to Headquarters from the NOC. Although unattended operation (NOC unattended) was possible from Headquarters to the NOC if suitable lines were found, the reverse was not true. It should be noted also that the very requirement for calling an intermediate operator (Gateway) tended to discourage initiation of Rapifax transmissions by personnel at Headquarters.

To improve the quality of Rapifax transmission signals, a procedure was developed in which the establishment of communications was initiated from the NOC. Under this procedure the NOC operator would dial the Gateway operator on a commercial telephone line; the Gateway operator would then patch the NOC Rapifax directly into the MSFC Rapifax network without the need for FTS. This procedure allowed successful transmissions to be accomplished slightly more often than did the previous procedure, but system reliability was still unacceptably poor (about 25% of the attempted transmissions were completed properly). The new procedure was extremely expensive, since it required a commercial long-distance call to Huntsville, Alabama for the duration of the intracity transmission. Furthermore, the procedure did not allow unattended transmission from Headquarters to the NOC—the direction of heaviest information flow.

For the reasons described above, the NOC Rapifax was connected into the MSFC Rapifax network in early December 1976. Since the

installation of the direct line was completed, transmissions between Rapifax units have been conducted with high reliability in an unattended mode of operation. Although the transmission still takes place via Huntsville, Alabams, the improved transmission results from use of dedicated lines that are part of a NASA network. The capability for using the dedicated lines and another network, such as FTS or commercial, could be implemented simply by installation of the appropriate line and an inexpensive modification available from Rapifax.

2.4 Conclusions and Comments

Our remarks here are confined to just those features of the experiment that seem to be peculiar to the conduct of work at a distance, and which we therefore believe can be generalized to all distributed work systems of this type. We have attempted to pass over points which appear to be characteristic of one vendor's product or another, granted however that our remarks must still be cast in the light of the specific and rather modest system configuration our budget constrained us to adopt, as well as the rather limited duration of the experiment as conducted so far.

a. Equipment. The hardware elements we employed have been described earlier in this Section. A dual-cassette station was felt to be mandatory for the experiment, but our choice of vendor was limited to the Wang Corporation because their Model 1222 TC was the only unit meeting our specifications that was available for immediate delivery when we placed the order. One unit was procured at first, and we attempted to communicate with it to an IBM 2741 terminal downtown, believing that they should be compatible; our enlightenment has been described above. Our inability to communicate directly between the two was due to the fact that the

Wang unit communicates in IBM Correspondence Code format, while the 2741 we used required a different format. Hence the need for WYLBUR as an intermediary. In view of the preponderance of equipment using ASCII and EBCDIC code throughout the industry, it would in retrospect have been less trouble to have had a terminal that communicated in one of these formats.

So standardization of intermodule codes is as important here as it is in other communications disciplines. For that matter, so is standardization of communications protocols. Because of differences in handshake conventions we were able to transmit from the Wang 1222 to an IBM Communicating Mag Card A Selectric, but not in the reverse direction. Of course, standardization of operational features is still another matter, as we probably would have found if we had attempted to communicate directly between the Wang unit and a Diablo or Qume "daisy wheel" printer.

During 1975, multi-user CRT-based word processing stations, which we were to use later according to the recommendations of the task team, began appearing on the market in a great profusion of models that has continued to propagate. Some of these models included a telecommunications option, or at least the promise of such an option, which would allow us to continue evaluation of the NOC in a subsequent phase based on the more powerful CRT-based systems. The CRT, of course, would prove to be a superior medium for text editing because it can display modified text instantaneously, and without the need for paper. Raw text, however, is still entered through a keyboard, and it makes little difference whether the keyboard is associated with a CRT or a typewriter. CRT based or

not, however, final copy is always delivered on a typewriter, and typewriters must be supplied with paper. This aspect of the operation cannot be automated, even though continuous-feed arrangements can be attempted. One difficulty is that perforated forms show ragged edges when they are separated, and many people consider this unacceptable. In one experiment, we used NASA letterhead bond specially spot-glued onto a continuous pin-fed carrier roll. This was successful to a certain extent, but there still remains the problem that different kinds of paper are required for different kinds of documents, e.g. letterhead bond, second sheets, memorandum sheets, special forms, "rainbow" sets of multicolored carbon copies for distribution to appropriate offices, and so forth.

So we came to realize that an attendant has to be available at the user location to insert paper and align it properly in the machine before the finished text can be printed. The attendant is also needed to make other adjustments, such as setting margin stops, placing tabs, and selecting format options like margin adjust/justify, pitch size, etc. The conclusion is that completely automated operation at the user site is an impossibility, given the current state of typewriter technology. And unless the volume of output at the user site warrants a full-time attendant it would probably behoove the management to assign other duties to him as well, such as routine local typing on the same machine while it is idle, or perhaps the operation of the facsimile machine, or maybe even routine maintenance of all the equipment.

Communication line losses aside, the facsimile transceivers and the audio recorder/playback device

performed adequately. Here especially, however, the presence of an automatic answer feature is all but essential. Fortunately, this feature is readily available, and presents no problem to installation.

b. Personnel and Procedures. One of the most important lessons we learned is that (promotional literature notwithstanding) the proper utilization of word-processing terminals requires typists of higher-than-average intelligence. Word-processing terminals have many more user options than office typewriters, and are therefore considerably more complex to operate. All of these options, e.g. insertions and deletions of words, lines and paragraphs, tape scan, transmit, etc., involve function buttons and typed commands, so the operator must have the aptitude to become proficient in what really amounts to minor programming language. In one installation we visited, a user recounted to us that sometimes when he indicated typing errors in a first draft, the second draft would come back with the indicated corrections, but with new errors that never existed before. Later he discovered why: some operators were unable to master the search and insertion features of the terminals, and were simply retyping the documents instead! It is, as Ref 1 points out, quite likely that future NOC staff members will have to be recruited from a new generation of typists, accountants, draftsmen and managers, receptive to electronic data processing equipment, trained on it, and unprejudiced by long and habitual dependence on the old machines that are ready to be replaced.

Even with the simple station-to-station configuration we utilized, the need for establishing orderly

Ref 1: "A Study of the Remote Neighborhood Office Center", S. Ross and Company Final Report, Contract NASw-2743, 31 August 1976

operational procedures was repeatedly brought home to us. On one occasion, for instance, a job initiator complained that he had received no response a week after submitting work to the NOC. Tracing the problem, we found that his copy had been transmitted during a period of facsimile malfunction, and the typist had never been aware of his having sent the material. A confirmatory signal of "transmission received", perhaps accompanied by a rough estimate of completion time, should have been standard procedure. Then, if such confirmation were not received, the job initiator would have known to follow up or attempt to repeat the transmittal.

How does the NOC approach compare with conventional typing methods? This is perhaps the central question at issue, but one to which we cannot provide a clear-cut answer because our efforts to date have obviously not yet generated the breadth of operational experience needed to draw definitive conclusions. The problem is not one of getting the equipment to function properly, nor is it so much one of measuring throughput volume, or neatness, or any of the other commonly posed standards of measurement—although they are all of importance. What is more elusive is developing a common base of comparison between the two approaches. For example, if one grants our earlier assertion that more alert and intelligent operators are required to run word-processing equipment than conventional office typewriters, does it not follow that the word-processing specialists will be more motivated, produce more output, at a faster rate, with fewer errors, and apply themselves more diligently to the tasks at hand? The NOC typist has produced finished output of the order of one hundred pages a day on some

occasions, but does this mean that she would not have produced as much working at the downtown location? These questions are obviously quite complex, and the answers to them must await further tests which perhaps would measure the performance of the same typist at each location, or a statistically significant sample of typists of differing levels of ability working simultaneously at both stations.

3.0 MANAGEMENT INFORMATION SYSTEM (MIS)

Under the scope of Task B, efforts to develop a Management Information System (MIS) for Headquarters Administrative Correspondence were undertaken. As a test prototype for systems of this type this particular MIS is intended to aid the Administrator's Communications Center in the tracking and controlling of the Administrator's mail. When this pilot project was begun, the Communications Center was using a manual system centering around a Correspondence Control Form (NASA Form 545). It was decided that this form would be maintained in the automated MIS so that continuity between the two systems would be preserved.

In February, a decision was made to demonstrate the MIS using the IBM 370 at NASA Headquarters as the processor and an IBM 2741 terminal as the access device. In March, a COBOL program was written, providing for the input of data from the Correspondence Form 545, the storage of the information in a data file and the retrieval of the information onto the form. In April, this COBOL program was installed on the IBM 370 at NASA Headquarters. A preliminary demonstration was given to Ms. Jean LeCompte (Code AEM), Supervisor of the Communications Center, and some of her staff. At this time, Ms. LeCompte made some initial comments indicating that she would like to have some prompting messages for her people. These modifications were made to the program in May.

Formal instruction in the use of the program was delayed until August due to administrative problems in getting a 2741 terminal located in the Communications Center. However, once this was achieved, Ms. LeCompte's staff were instructed in the use of the program. As usage increased many suggestions were made by the Communications Center staff on how they would like the program to work to accommodate their needs more efficiently. The main

suggestion, which resulted in a basic restructuring of the COBOL program, was that of doing away with the actual Form 545 and providing for the field names to be presented to the operator in running format when entering data. This modification and a means of editing input data were incorporated during the month of September.

A demonstration of the MIS was given to Mr. Fernandez and Mr. Andrews in September, with Ms. Lecompte's staff operating the terminal, entering and retrieving data. Throughout the months of October and November, the Communications Center used the MIS, making suggestions for program changes and building up a sizable data base. During this period, they collected data and formed opinions which will allow them to evaluate the current system and make suggestions for an ultimate operational system.

In November a User's Guide was prepared and delivered to the Communications Center's staff. It was used as the basis for a number of training sessions held in November and December to familiarize Communications Center personnel with the details of operation of the improved system.

We undertook a study of computer hardware, to identify the configuration that would be most suitable for implementing the MIS function within a unified NOC/MIS/AOC environment. Equipment categories we surveyed included large-scale processors (IBM 370), general-purpose minicomputers (e.g. PDP-11) and minicomputer-based turnkey configurations, customized to suit the application envisioned (e.g. Astrocomp, Q1). Our recommendation was that a PDP-11 minicomputer be leased for the next phase of this pilot project. Difficulties have been encountered while using the IBM 370 that indicate that it would not be acceptable for an operational system. The main difficulty relates to the computer response time and availability. Due to the nature of the MIS problem, it is

required that a fairly large data base be searched sequentially when retrieving information. Presently, the data base is only a fraction of its ultimate size and the response time has varied from as little as 30 seconds to as much as 20 minutes, depending on the time of day and the number of users on the system. As the size of the data base increases, it is expected that the response time will also increase. Since the response time is already unacceptably long, a dedicated processor is recommended.

The proposed PDP-11 system would be configured with a COBOL compiler to insure that the transition from the IBM 370 to the PDP-11 is smooth. It is anticipated that the software would be enhanced on the PDP-11 to include the automatic tabulating of statistics necessary for assessing the daily operation of the Communications Center. These statistics include the total daily number of items processed, the number of items due today, the number of items due from a particular office, and the number of items concerning a particular subject. The operational system on the PDP-11 would also include a feature for security of the files. Presently, the only security feature of the program is the requirement of a specific password to log onto the system and access the files. This password is known by all Communications Center people. Any sensitive documents that are entered into the data base are labeled as "restricted" in the abstract describing the correspondence. If, at a future point in time, more elaborate security features are required, this could be added.

If a decision to lease a PDP-11 is made, the ultimate goal of tying together the individual tasks named in the introduction could be achieved. That is, Neighborhood Office Center (NOC) word processing, Headquarters word processing and MIS could be integrated using a central computer. The next phase of the effort should be to determine whether the secondary word processing functions could be implemented without degrading the

performance of the MIS function or reducing its response time.

Under the scope of the contract, a "User's Guide to MIS for Correspondence Control" was prepared for the Communications Center's staff. It consists of four major sections:

1. LOGON Procedures - steps necessary to connect the user to the 370 system and execute the COBOL program.

2. ENTER DATA Procedures - steps necessary to enter data into the data base.

3. UPDATE Procedures - steps necessary to edit existing data in the data base.

4. SEARCH Procedures - steps necessary to retrieve data from the data base.

The User's Guide has been delivered to the Technical Monitor and to the staff of the Communications Center and is the basis for the training of MIS operators.

4.0 EVALUATION OF THE NASA TELECONFERENCING NETWORK

The NASA Teleconference Network has been considered as a possible medium for interconnecting stations throughout an experimental NOC system. We therefore undertook a study to assess how suitable it might be for such an application, as well as to provide a body of data from which its effectiveness in reducing the cost of travel throughout NASA could be evaluated. During the course of this effort a computer program was developed to tabulate the responses of users as expressed on NASA Forms T42 (Fig. 4.1) and 1541 (Fig. 4.2). Objective information such as teleconference start and stop time, estimated numbers of trips saved, and identification of participating facilities was prepared for the data base.

Later it was decided that subsequent data should be tabulated on the basis of the reports (Figure 4.3) received from the Marshall Space Flight Center (MSFC) 4-wire Centrex. The major advantage of using 4-wire Centrex data, of course, is that system use can be evaluated without the inaccuracy and inconsistency inherent in the manual completion of forms. In the past, this phenomenon has biased statistics in the direction of those centers that encourage or require completion of the forms; centers that have not filled out forms regularly have appeared to use their teleconference facilities infrequently, if at all. In this sense, the 4-wire Centrex data provide a more accurate record of system utilization.

However, the major disadvantages of the 4-wire Centrex data are that they omit a tabulation of the number of participants (i.e., individuals; facilities are counted) and the number of trips saved by each conference, and that they include the use of only the 4-wire overhead conference room system. Data on the use of Bell 50-A or Speakerphone systems are not available through the 4-wire Centrex. From careful examination of the teleconference

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TELECONFERENCING PILOT PROJECT USE RECORD

Would you please complete one page of this record every time the Teleconference room is used? This information is required for the evaluation of the Teleconference Service. *PLEASE LEAVE THIS RECORD IN THE BINDER.* Thank you for your cooperation.

YOUR ORGANIZATION	TIME OF MEETING *(A.M. or P.M.)*	
	START	COMPLETION

BRIEF PURPOSE OF MEETING

NUMBER OF PARTICIPANTS		FACSIMILE USED	NUMBER OF PAGES	
AT THIS LOCATION	AT ALL LOCATIONS	☐ YES ☐ NO	TRANSMITTED	RECEIVED

NAMES OF ATTENDEES AT THIS MEETING *(Use additional sheets if necessary)*

YOUR COMMENTS ON THE TELECONFERENCE FACILITIES

IMPORTANT: HOW MANY PARTICIPANTS IN THIS TELECONFERENCE FACILITY WOULD HAVE TRAVELED TO ANOTHER LOCATION FOR THIS MEETING?

LISTING OF LOCATION(S) FROM WHICH TRAVELERS WOULD HAVE HAD TO DEPART IN ORDER TO PARTICIPATE IN THIS MEETING

PREPARED BY ▶	NAME *(Please print)*	SIGNATURE	DATE

NASA FORM T42 DEC 74

Figure 4.1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TELECONFERENCING PILOT PROJECT USE RECORD #59 - B521-J

Would you please complete one page of this record every time the Teleconference room is used? This information is required for the evaluation of the Teleconference Service. *PLEASE LEAVE THIS RECORD IN THE BINDER.* Thank you for your cooperation.

YOUR ORGANIZATION	INSTALLATION	CODE
TN/OTDA, Joseph Beicher	NASA HQ	TN

MEETING DATA

DATE	TIME OF: START	TIME OF: ENDING	BLDG. NO.	ROOM NO.
Aug. 3, 1976	11:00 AM	12:00 PM	FOB-10B	521-J

SUBJECT

Conversion Teletype Net to ARS

EQUIPMENT USED

☒ CONFERENCE ROOM OVERHEAD SYSTEM *(MSFC wideband, 4-wire)*

BELL 50-A PORTABLE SPEAKER SET

☒ FTS VIA MSFC ☐ FTS DIRECT ☒ MSFC CENTREX *(2-wire)*

DESK SPEAKER PHONE

☐ FTS VIA MSFC ☐ FTS DIRECT

RAPIDFAX FACSIMILE IN SUPPORT OF TELECONFERENCE ☐ YES ☐ NO

NUMBER OF PARTICIPANTS *(Estimated)*: IN THIS ROOM	NUMBER OF PARTICIPANTS *(Estimated)*: AT ALL LOCATIONS	ESTIMATED NUMBER OF TRIPS SAVED *(All participants)* BY THIS TELECONFERENCE
9	60	1 Trip to All Locations

FACILITIES PARTICIPATING

☒ 1. ARC	☒ 2. FRC	☒ 3. GSFC
☒ 4. JPL	☒ 5. JSC	☒ 6. KSC
☒ 7. LARC	☒ 8. LERC	☒ 9. MSFC
☐ 10. MAF	☒ 11. HQS	☒ 12. NSTL
☐ 13. RKDT	☐ 14. RI	☐ 15. THIO
☐ 16. SAMSO	☒ 17. WFC	☐ 18. WSTF
☐ 19. MDAC	☐ 20. ALL NASA CENTERS	☒ 19. WLOD

20. OTHER *(List if not indicated above)*

REMARKS

Teleconference successful. All facilities technically acceptable. No difficulties either procedural or technical.

PREPARED BY ▶	NAME *(Please print)*	DATE
	Joseph R Beicher	August 3, 1976

NASA FORM 1541 FEB 76 REPLACES NASA FORM T42 WHICH WILL NO LONGER BE USED.

Figure 4.2

CONFERENCE NO: 0197	START TIME: 1000 12-5-75	END TIME: 1600 12-5-75

O 201 MSFC		PP 221 HQ ADMIN		240 MSFC	X	PP 276 (3-2866) JSC		PP 3-2512 HQ OAST	
PP 202 (3-0094) HQ OA		222 MAF		PP 243 (3-4087) JPL		280 SAMSO		PP 3-4697 MSFC	
PP 203 (3-0395) HQ OSS		223 KSC		256 MSFC		281 ROCKWELL		685-3700 MAF	X
PP 205 (3-1096) FRC		227 ROCKWELL		PP 260 (3-5088) LaRC		PP 284 (3-1183) WFC		755-3020 WASH	X IN 1200
206 ROCKWELL 985-2263	X 4-WIRE UP AT 1228	228 HQ	X DOWN 1200	262 (3-5515) THIOKOL		PP 292 (3-3299) NSTL		—	
209 JSC	O	PP 235 (3-3082) GSFC		263 NSTL		295 JSC		—	
210 KSC	X	PP 236 ARC		PP 266 (3-0457) LeRC		PP 3-0288 HQ ADMIN		—	
O 211 HQ		238 HQ		272 JSC		PP 3-2512 HQ OT&DA		—	

TOTAL TIME: 360 min

SHUTTLE SAT

SPACELAB

PILOT PROJECT

JRM

Figure 4.3

evaluation forms, however, it appears that the less sophisticated the communications medium and the less formal the teleconference, the less likely the user is to complete an evaluation form; thus, data other than 4-wire system data received on teleconference evaluation forms would continue to be only slightly representative of the truth.

An analysis of data from the period July 1 through September 30, 1976 shows that 114 of the 553 teleconference reports received, approximately 20%, were from the MSFC 4-wire Centrex data. The correlation of this 20% sample with past form data is either excellent or justifiable. For example, the average number of facilities participating and the average duration of each teleconference, as determined from all 553 reports and from the 114 4-wire Centrex reports, are shown below:

	All Reports				4-Wire Centrex
	July	August	September	Jan-Sept	July-Sept
Average number of facilities per teleconference	2.9	2.7	2.8	2.8	2.8
Average duration (hours)	2.2	2.3	2.5	2.4	1.7

Teleconferences longer than two hours were reported in only 24% of the 4-wire Centrex data but in 39% of all the evaluation forms received. The discrepancy in the average duration of a teleconference as reported in the two sources can be explained in two ways. The major reason for the longer duration of conferences reported on evaluation forms is that participants in long conferences are more likely to complete a form. An individual involved in a 15-minute teleconference will

frequently not bother to take a few extra minutes to complete a form; a short teleconference may seem to him to be an insignificant part of the evaluation. Second, the longer teleconferences tend to take place in the convenience of the user's own office with a system other than the overhead conference room (4-wire) system. The sophisticated 4-wire system is more likely to be used for formal presentations and upper-level management discussions which are generally concluded sooner than teleconferences involving such personnel as project managers. An average duration of 2.0 hours is probably closer to the time average for all systems. The data were compiled quarterly and submitted to Mr. S. W. Fordyce, Code ECF, for incorporation with a quarterly report on teleconference activity.

5.0 PERFORMANCE EVALUATION FOR THE CODE EC ADMINISTRATIVE OFFICE CENTER (AOC)

The AOC, which began operation in an integrated configuration in November 1975, was staffed by four full-time operators and a supervisor. Input to this word processing center was provided either as handwritten or typed "hard copy" or as dictation on an IBM 6:5 Tone Input System.* The word processing machinery in the AOC consisted of five single-cassette, dual-cassette, and magnetic card versions of the Xerox 800. The supervisor acted as a dispatcher, distributing incoming work to the staff, proofreading completed documents, and returning work to the originators. When necessary, the supervisor would help accommodate peak loads by operating her own Xerox 800.

A number of criteria were developed to enable various facets of AOC performance to be evaluated. Individual operator performance was of interest, for example, to those concerned with maximizing the efficiency of the operation; if, for instance, a particular operator was determined to be deficient in some aspect of machine operation such as editing, then additional training for that operator might be recommended, or job assignments might be changed. Furthermore, knowledge of overall operator performance would provide management with quantitative information with which to support incentive awards and promotions.

Still other objectives could be achieved by analyzing the various items of tabulated data that indicated the quality of system performance. For example, the time required to complete such diverse jobs as producing charts and tables, equations and technical typing, multiple form letters, mailing lists, complex outlines, and straight typing can be used to establish priorities with which the various jobs should be processed by the dispatcher. The more time-consuming efforts, of course—all

* This system was described in Section 2, above.

other factors being equal—would be processed after other jobs of comparable length, time of receipt, and importance.

Detailed knowledge of output from the AOC affords an assessment of the performance of this advanced method of document preparation, in contrast with more standard typing methods. Such assessment enables the cost-effectiveness of word processing in a particular office to be determined and indicates the improvement in efficiency (if any) realized from an investment in equipment and, in all likelihood, from a reduction in the number, but not skill, of the personnel involved. Finally, compilation of input/output statistics provides a sound means of justification of additional equipment and personnel as the workload increases.

Statistics to aid in the evaluation of the AOC were tabulated from data recorded by AOC personnel on a designated form. The form used was redesigned several times during the operation of the AOC. Initially it was merely a job control form that allowed for the recording of proper labeling information, typist data and time-in/time-out data for original and revision work. This form is shown in Figure 5.1. After a short period of time, it became obvious that this form was inadequate for compiling meaningful statistics, since it did not call for the recording of all data deemed necessary for proper evaluation. Furthermore, the original form was attached to the work package that traveled between the AOC and the originator, and was frequently misplaced or lost during transit. This led to the development of a second form, an operator's AOC log sheet (Figure 5.2), used in conjunction with the job control form.

The operator's AOC log was adapted from a standard IBM word processing operator's log to meet the particular requirements of NASA's AOC. Some fields requested the recording of information in coded form. The code definition sheet is shown in Figure

JOB CONTROL NO.: PRE-PRINTED MAILED/SIGNED: ____________

ORIGINATOR/CODE: PHONE/ROOM: ____________

ACTION CONTROL NO(S): ____________

SUBJECT: ____________

STORAGE UNTIL: ( ) DRAFT ( ) FINAL

TYPIST DATA: MEDIA:

TAPE NO(S): ________ ________ ______ ( ) TAPE ( ) CARD

REF. NO(S): ________ ________ ______ ( ) SINGLE ( ) DUAL

REMARKS:

ORIGINAL	IN		OUT		DUE: DATE ______	TIME ______
	DATE	TIME	DATE	TIME	TYPIST:	

REVISIONS	IN		OUT		IN		OUT		IN		OUT	
	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME
TYPIST:	________		________		________		________		________			

Figure 5.1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OPERATOR'S AOC LOG

NAME

TODAY'S DATE

IN		OUT		DATE REQUIRED	WORK DAYS ELAPSED	JOB NO.	TAPE/CARD NO.	CODE	AUTHOR'S LAST NAME	PRECINCITY	APPLICATIONS	INPUT	PROCEDURE	SPACE	VOLUME BY LINE	ENVELOPES TYPED	STOCKED	COMMUNI
DATE	TIME HRS : MIN	DATE	TIME HRS : MIN															
	:		:															
	:		:															
	:		:															
	:		:															
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Figure 5.2

5.3.

After the log sheet was used for a few weeks, it was decided that it should include the recording of data reflecting individual operator ability. As indicated in the January and February statistics, only total job time was extractable. Since a job went through several stages before its completion, it was decided that the time required for each stage was meaningful and should be recorded. Accordingly, another Operator's Log (Figure 5.4) was designed and put into use on an interim basis. The final form eventually printed (NHQ Form 132) and regularly used, similar to the one in Figure 5.4 with one minor exception, appears in Figure 5.5. This form reflected original keyboarding time/lines, proofing and playback time/lines, and revision keyboarding time/lines. A total "in center" turnaround time could also be calculated from the in and out times recorded, as well as the intermediate times involved for operator handling.

Another consideration in the design of the word processing control log was its facility for automating the compilation of statistics. However, the statistics were always calculated manually because of the fluctuation in the data recorded, the form used for recording the data, and the variation in the type of statistics requested by the administrative people for AOC evaluation.

The statistics recorded are attached to the end of this section. Information pertaining to work completed during the months of June and July was not tabulated. The types of statistics necessary were undergoing analysis during these months and it was decided not to calculate any figures until a concrete decision could be made as to what was needed. The August data reflect most of the requests made as a result of this analysis. Since some types of requested statistics required the recording of more data, the tabulating of these does not show up until the

CODE INSTRUCTION SHEET

PRIORITY

S - Rush
R - Routine
J - Special Project

APPLICATION

A - Memo
B - Letter
C - Narrative/Text (Cong)
D - Narrative/Statistical (Budget)
E - Statistical/Tabular
F - Nonstatistical/Tabular
G - Variable Sets (Repetitive Ltrs)
- other

INPUT

D - Dictated
C - Typed Copy
H - Handwritten
Z - Prerecorded Magnetic Tape or Card

PROCEDURES

R - Record Rough Draft
P - Record & PlayClean Rough Draft
T - Play Final with Typo or Light Revision
H - Play Final with Heavy Revision
F - Play Final
M - Playout Stored Material

SPACE

S - Single
D - Double

VOLUME

Lines (Indicate No.)

ENVELOPES

Typed - Indicate No.
(other uses are for labels)

STORED - % OF STORED

N - No Storage
0 - 1% - 10%
1 - 11 - 20%
2 - 21 - 30%
3 - 31 - 40%
4 - 41 - 50%
5 - 51 - 60%
6 - 61 - 70%
7 - 71 - 80%
8 - 81 - 90%
9 - 91 - 100%

EQUIPMENT

1 - ETS Tape Typewriter
2 - ETS Card Typewriter
3 - WANG (CF)

*WANG (Communicating Feature)

Figure 5.3

FOLDOUT FRAME (

OPERATOR'S NAME ______________ DATE ______________

JOB CONTROL NUMBER	IN DATE	IN TIME	AUTHOR	ORG. CODE	DUE DATE	DUE TIME	INPUT	APPLI-CATION	KEYBOARD TIME BEGIN	KEYBOARD TIME EN

INPUT

D - Dictated

T - Typed Copy

H - Handwritten

APPLICATION

M - Memo

L - Letter

R - Report (narrative of 10 pages or less)

S - Statistical

F - Form

V - Variable Info (Repetitive ltrs. or fill-ins)

P - Manuscripts (narrative of 10 pages or more)

O - Other

NOTE: A "D" BEFORE ANY OF THE ABOVE LETTERS INDICATE A DRAFT - AN "F" INDICATES FINAL COPY.

DATE ________________

		DUE				KEYBOARDING			PROOF/PLAYBACK			REVISION/KEYBOAR			OUT	
AUTHOR	ORG. CODE	DATE	TIME	INPUT	APPLI-CATION	TIME BEGIN	TIME END	LINES	TIME BEGIN	TIME END	LINES	TIME BEGIN	TIME END	LINES	DATE	TI

Figure 5.4

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WP CONTROL LOG

OPERATOR'S NAME

JOB CONTROL NO.	IN		AUTHOR	ORG CODE	DUE		INPUT (Check)			APPLICATION*	KEYBOARDING		
											TIME		
	DATE	TIME			DATE	TIME	D	T	H		BEGIN	END	LINES

*APPLICATION KEY ▶

M – MEMO L – LETTER R – REPORT *(Narrative of 10 pages or less)* S – STATISTICAL F – F

P – MANUSCRIPTS *(Narrative of 10 pages or more)* O – OTHER

NOTE. – A "D" before any of the letters indicates a draft; an "F" indicates final copy.

HQ FORM 132 MAR 76

...TION	OPERATOR'S NAME [illegible] 2	DATE

	DUE		INPUT (Check)			APPLI-CATION*	KEYBOARDING			PROOF/PLAYBACK			REVISION/KEYBOARD			OUT	
							TIME		LINES	TIME		LINES	TIME		LINES		
	DATE	TIME	D	T	H		BEGIN	END		BEGIN	END		BEGIN	END		DATE	TIME

R – REPORT *(Narrative of 10 pages or less)* S – STATISTICAL F – FORM V – VARIABLE INFO *(Repetitive letters of fill-ins)*

O – OTHER

...; an "F" indicates final copy.

Figure 5.5

GPO 905.166

October report, due to the transition of data being recorded in September.